OVAL

Psonic-1

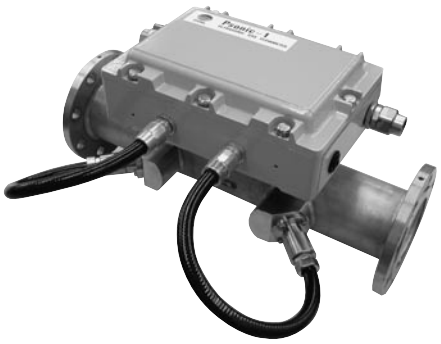
Ultrasonic Gas Flowmeter

GENERAL SPECIFICATION

GS.No.GBM002E-14

■ GENERAL

Using our prominent sensing technology and experience, this ultrasonic flowmeter for gas service, the Psonic-1, has achieved a high degree of meter accuracy and sensitivity. Its performance is remarkable under extremely low pressure and flow rate ranges. By using a built-in microprocessor plus communication interface (RS- 485), its transmitter enables you to establish and alter parameters such as flow range and output pulse units, and verify self diagnostics remotely.

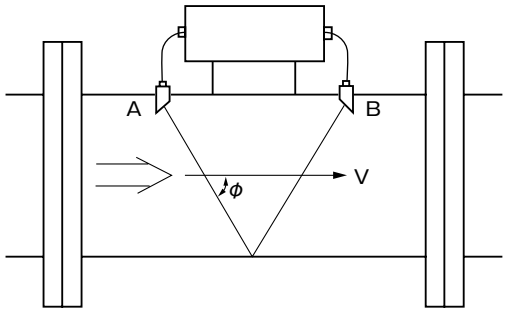


■ FEATURES

1. Precisely measures over a broad flow range from the very low flow range. Flow velocity resolution is 1 mm/sec.
2. Accepts bidirectional flows - both forward and reverse flow.
3. Has intelligent capabilities to remotely configure and change parameters such as flow range, output pulse units, and nominal size, and monitor the operating status of the meter with self-diagnostic capability with a built-in communication interface (RS-485).
4. Accuracy is guaranteed by fully-equipped testing facilities, using actual air flows.
5. Simple design with no moving parts offers long life and no aging degradation of accuracy.
6. Saves energy with no pressure loss.

■ PRINCIPLE OF MEASUREMENT

Operation is based on the time differential of ultrasonic sounds traveling from one transducer to the other, taking turns in sending and receiving between two transducers A and B. The Psonic-1 uses two methods to enable accurate gas flow management without sacrificing stability. One is the "single reflection" method which allows high flow velocity resolution unaffected by swirls in the flow. The other is the "differencial between propagation time reciprocals" method which makes the computing process independ of sound velocity. (See figure below)



Principle of Measurement

Formula

Assuming that

Tab : Travel time from transducer A to B (s)
Tba : Travel time from transducer B to A (s)
L : Travel length of ultrasonic wave (m)
C : Sound velocity in the process gas (m/s)
V : Flow velocity in the pipe (m/s)
ϕ : Angle at which the traveling ultrasonic wave intersects the pipe axis (centerline)

$$Tab = \frac{L}{C + V\cos\phi} \quad \cdots\cdots\cdots (1)$$

$$Tba = \frac{L}{C - V\cos\phi} \quad \cdots\cdots\cdots (2)$$

$$V = \frac{L}{2\cos\phi}\left(\frac{1}{Tab} - \frac{1}{Tba}\right) \quad \cdots\cdots\cdots (3)$$

Assuming the flowmeter pipe cross section of flowmeter is A (m^2), flow rate Q (m^3/h) is represented by the formula

and thus, the flow rate in Eq. (4).

■ GENERAL SPECIFICATIONS

<table>
<tr><th colspan="2">Item</th><th>Description</th></tr>
<tr><td colspan="2">Nominal size</td><td>50, 80, 100, 150, 200, 250, 300mm (350 to 600mm also can be manufactured.)</td></tr>
<tr><td colspan="2">Flange ratings</td><td>JIS 10, 20, 30K RF, JPI 150, 300RF</td></tr>
<tr><td colspan="2">Applicable fluids</td><td>General gases (air, natural gas, nitrogen, etc.) except steam. Gases below 0.8kg/m^3 in density, gases of large ultrasonic attenuation (e.g., carbon dioxide, hydrogen, helium), gases containing a large quantity of water (e.g., moist gas with 100 % humidity), corrosive gases (e.g., hydrogen sulfide, nitrous acid, nitric acid, ammonia, chlorine, NOx, SOx) are unacceptable.</td></tr>
<tr><td colspan="2">Flow range</td><td>See flow range table on page 3.
(Accepts a range from –30 to +30m/s.) (※1)</td></tr>
<tr><td colspan="2">Low flow cutoff</td><td>Any setpoint (standard setting: 0.1% of FS)</td></tr>
<tr><td rowspan="2">Operating temperature range</td><td>Process</td><td>–30 to +80°C (When used in hazardous area: –10 to +60°C)</td></tr>
<tr><td>Ambient</td><td>–20 to +60°C (When used in hazardous area: –10 to +55°C)</td></tr>
<tr><td colspan="2">Max. operating pressure</td><td>Standard type: 1.96MPa (Depends on flange rating.) High press. service (special): 10MPa</td></tr>
<tr><td colspan="2">Accuracy
(※2)</td><td>①±1% of RD ±0.03% of FS (above 10^4 in Reynolds number) ... see meter errors on page 4.
or ② ±1% of FS (above 2300 in Reynolds number)
NOTE 1: FS is the max. flow rate in the flow range table.
NOTE 2: In the analog output, add ±0.1% of FS to the figure above.</td></tr>
<tr><td colspan="2">Repeatability</td><td>±0.3% of RD (above 1/10 of the max. flow rate)
±0.03 % of FS (below 1/10 of the max. flow rate)</td></tr>
<tr><td colspan="2">Flow velocity resolution</td><td>1mm/s</td></tr>
<tr><td rowspan="2">Materials</td><td>Meter body</td><td>SUS304TP</td></tr>
<tr><td>Flange</td><td>Nominal size 150mm and smaller: SUS F304 Nominal size 200mm and larger: SF440A (SUSF304 option)</td></tr>
<tr><td colspan="2">Output
(※3)</td><td>Pulse : Open collector Max. 30V, 50mADC
<table>
<tr><th rowspan="2">Nominal Size
(mm)</th><th colspan="3">Pulse Units (L/P)</th></tr>
<tr><th>0.1</th><th>1</th><th>10</th></tr>
<tr><td>50</td><td>○</td><td>◎</td><td>–</td></tr>
<tr><td>80</td><td>○</td><td>◎</td><td>–</td></tr>
<tr><td>100</td><td>○</td><td>◎</td><td>–</td></tr>
<tr><td>150</td><td>–</td><td>◎</td><td>○</td></tr>
<tr><td>200</td><td>–</td><td>○</td><td>◎</td></tr>
<tr><td>250</td><td>–</td><td>○</td><td>◎</td></tr>
<tr><td>300</td><td>–</td><td>○</td><td>◎</td></tr>
</table>
◎ : Standard
○ : Acceptable
– : Unacceptable
Analog : 4 to 20mADC Max. load resistance 750Ω
Status : Open collector 30V, 50mADC max.
Select error (abnormal measurement) or forward/reverse signal.
Normal Open/Normal Close of the contact can be set as desired. (Standard setting: Normal Open)</td></tr>
<tr><td colspan="2">Field wiring (※4)</td><td>Min. 1.25mm^2 Finished cable O.D. ϕ10 to ϕ13.5mm</td></tr>
<tr><td colspan="2">Transmission length</td><td>Max. 1km</td></tr>
<tr><td colspan="2">Communication</td><td>RS-485</td></tr>
<tr><td colspan="2">Cable entry</td><td>G 1/2 internal thread with pressuretight packing-type lead-in fitting provided</td></tr>
<tr><td colspan="2">Power supply</td><td>85 to 264VAC, 50/60Hz</td></tr>
<tr><td colspan="2">Power consumption</td><td>Max. 33VA</td></tr>
<tr><td colspan="2">Construction</td><td>Explosionproof transmitter.: Flameproof Exd IIB T6 Sensor: Special explosionproof Exs II T6
Waterproof : IP65 equivalent</td></tr>
<tr><td colspan="2">Finish</td><td>Meter body : Munsell 2.5G 8/2 (except for stainless steel area)
Transmitter : Munsell 2.5G 8/2</td></tr>
</table>

※1 : This flowmeter accepts measurement of bidirectional flows. The forward direction is indicated as plus and reverse direction as minus. For details of flow direction, refer to Outline Dimensions on page 5. (Viewing from the side where the sensors are attached, the direction from right to left refers to forward direction.)

※2 : The above accuracy is during pulse output of total flow
In the case of analog output, 0.1% of full scale is added as described in NOTE 2.
The accuracy is assured on condition that the flowmeter is calibrated by OVAL calibration system or third-party calibration organizations.
For the accuracy assured flow range, refer to the table of Flow Ranges on page 3 or Delivery Specification.

※3 : When an error is assigned for status output, neither analog nor pulse signal is generated in case of reverse flow. In other cases, both analog and pulse signals are generated with the absolute value of flow regardless of the flow direction.

※4 : Should the TIIS explosionproof type be used where the ambient temperature is 50°C or higher, use a cable resistant to the temperature of 70°C or higher.

■ FLOW RANGES

This table of flow ranges indicates actual flow rate. If flow rate is given under standard conditions, it must be converted into the actual flow rate before determining the flow range and nominal size according to this table.

	Nominal Size (mm) / Accuracy / Visco. mm²/s		Minimum Flow rate (m³/h) 1	3	7	10	14	16	Max. Flow rate (m³/h)
Table A	50	①	1.5	5	11	15	21	24	230
		②	0.3	2	3	4	5	6	
	80	①	3	7	16	23	31	36	530
		②	0.6	2	4	6	8	9	
	100	①	3	9	21	29	41	47	900
		②	0.9	2	5	7	9	11	
	150	①	5	13	30	43	60	69	2100
		②	2	3	7	10	14	16	
	200	①	6	17	40	57	80	91	3400
		②	4	4	10	13	19	21	
	250	①	8	22	50	71	99	113	5200
		②	6	6	12	17	23	26	
	300	①	8.5	26	59	85	118	135	7500
		②	8	8	14	20	28	31	

Table B	Kind of Gas	Dens. (kg/Nm³)	Gas Pressure (MPa[gage]) at Temperature 20℃						Viscosity (mPa・s)
	Argon	1.785	0.33	0.04	–0.04	—	—	—	0.0209
	Ethane	1.357	0.58	0.13	0.00	–0.03	—	—	0.0085
	Ethylene	1.264	0.73	0.18	0.02	–0.02	—	—	0.0097
	Air	1.293	1.33	0.38	0.10	0.04	0.00	–0.01	0.017
	Oxygen	1.429	1.36	0.39	0.11	0.04	0.00	–0.01	0.0192
	Nitrogen	1.251	1.34	0.38	0.10	0.04	0.00	–0.01	0.0166
	Town gas	0.802	1.25	0.35	0.09	0.03	—	—	0.01
	Natural gas	0.828	1.30	0.37	0.10	0.04	—	—	0.0107
	Propane	2.020	0.30	0.03	–0.04	—	—	—	0.0075
	Butane	2.703	0.18	–0.01	–0.06	—	—	—	0.0069
	Methane	0.717	1.46	0.42	0.12	0.05	—	—	0.0103

NOTES ○ Accuracy column ①: ±1% of RD ±0.03% of FS (above 10^4 in Reynolds number)
②: ±1% of FS (above 2300 in Reynolds number)
○ Standard low cutoff flow rate (min. measurable flow rate) is about 1/1000 of max. flow rate).

● How to Determine the Minimum Flow rate

Find a value nearest (lower value) to the applicable gas pressure in Table B, follow the same column upwards and find a value intersecting the desired nominal bore in Table A for the minimum flow rate. In an example where the desired nominal size is 80mm and the gas is at a temperature of 20°C and pressure of 0.2MPa, then you have 16m³/h in Accuracy ①. Given below is the detailed calculation. If a more accurate minimum flow rate is desired, consult the factory.

(EXAMPLE) How to determine precise minimum flow rate

(1) From Tables A and B,

Pressure (MPa)	80mm, Min. Flow rate Accuracy ① (m³/h)
0.1	16
0.2	Qmin
0.38	7

By proportion,

$$Qmin = 7 + \frac{0.38-0.2}{0.38-0.1} \times (16-7)$$

$$\fallingdotseq 12.8 m^3/h$$

(2) You can also determine flow rate by kinematic viscosity.
The figure corresponding to the column below the kinematic viscosity indicated (mm²/s) is the minimum flow rate. At a given kinematic viscosity, the following expression is applicable:

$$\text{For Accuracy 1 : } Q1min\ (m^3/h) = \frac{\text{Kinematic viscosity } (mm^2/s) \times \text{Meter bore } (mm)}{35.4}$$

NOTE: See the Outline Dimensions on page 5 for the meter bore.

For Accuracy 2 : Q2min (m³/h) = 0.23 × Q1min

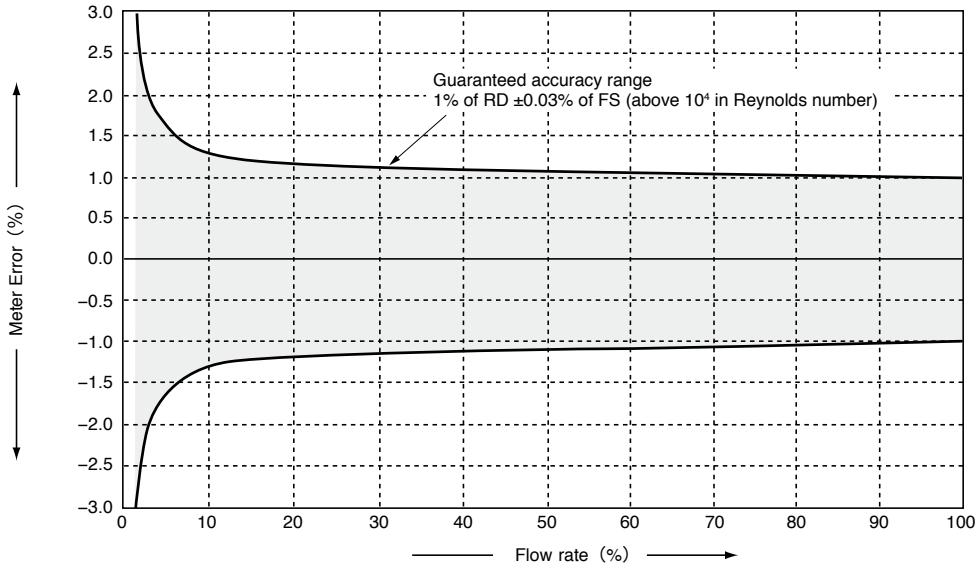
If kinematic viscosity is unknown, calculate the kinematic viscosity from Table B.
First, find the actual density from the density.

$$\text{Actual density} = \text{Density in Table B} \times \frac{273.15}{273.15+T} \times \frac{0.1013+P}{0.1013}$$

[where T and P are temperature used (°C) and pressure (MPaG)]

Divide the viscosity (mPa・s) in the right hand column in Table B by the actual density and multiply it 1000 times to obtain the kinematic viscosity (mm²/s).
Then substitute the obtained value into the formula above to obtain Q1min and Q2min.

■ METER ERRORS

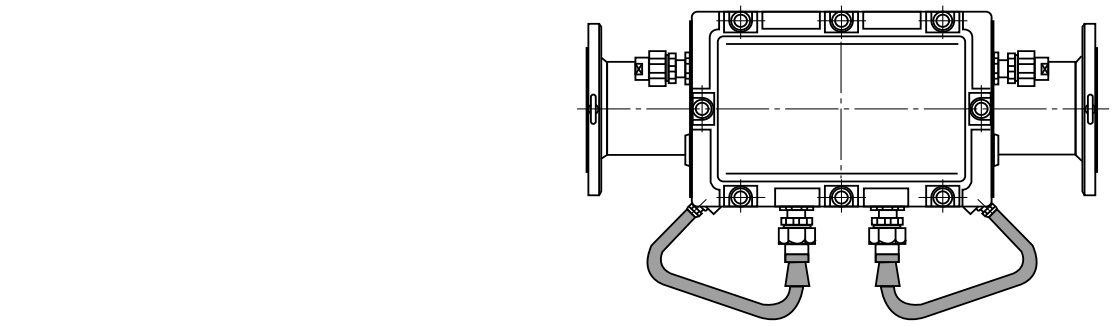


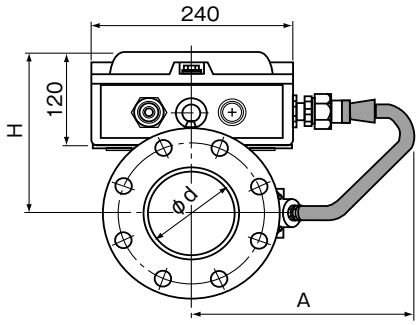
■ PRODUCT CODE EXPLANATION

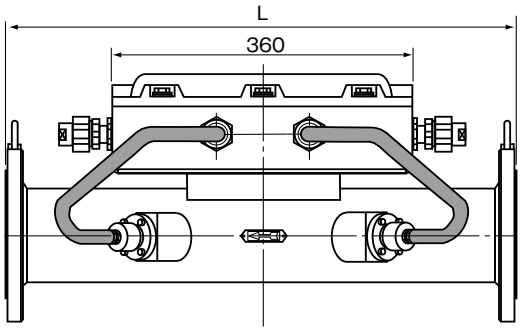
Item	Product Code																Description
	①	②	③	④	⑤	⑥	—	⑦	⑧	⑨	⑩	—	⑪	⑫	⑬	⑭	⑮	⑯	
Model	**U**	**P**	**1**																Ultrasonic gas flowmeter Psonic-1
Nominal size (※1)				**0**	**5**	**0**	—												50mm (2")
				0	**8**	**0**	—												80mm (3")
				1	**0**	**0**	—												100mm (4")
				1	**5**	**0**	—												150mm (6")
				2	**0**	**0**	—												200mm (8")
				2	**5**	**0**	—												250mm (10")
				3	**0**	**0**	—												300mm (12")
Meter body and flange material (※2)								**G**											SUS 304TP + SF440A
								D											SUS 304TP + SUSF304
								Z											Special
Flange rating									**1**										JIS 10K RF
									2										JIS 20K RF
									3										JIS 30K RF
									4										JPI 150 RF
									5										JPI 300 RF
									9										Other than above
Sensor (meter body) specifications										**1**									Standard
										3									Regulations compliant (low pressure)
										9									Ultrasonic calorimeter
Converter spec.											**3**	—							Explosionproof, integrally-mounted type
Power supply													**7**						85 to 264VAC 50/60Hz
Temperature input														**0**					None
Pressure input															**0**				None
Communication interface																**2**			RS-485
Output signal																	**1**		Pulse + Analog
																	2		Pulse + Analog + Bidirectional flow signal
																	3		Pulse + Analog +Alarm
Version																		**A**	Always "A"

※1：We also manufacture 350 to 600mm flowmeters. Consult our factory.
※2：D is only for flowmeters 150mm and smaller. G is standard for 200mm and larger, but D is also available upon request.

■ OUTLINE DIMENSIONS [Unit in mm]







Note) In the above situation, the direction from right to left refers to forward direction.

Nom. Size (mm)	L	d (※1)	H	A (Approx.)	Weight (kg) (Approx.) (※2)
50 (2")	500	52.7	175	210	27
80 (3")	500	78.1	200	230	31
100 (4")	600	102.3	215	240	39
150 (6")	600	151	245	260	52
200 (8")	600	199.9	270	290	62
250 (10")	750	248.8	295	310	95
300 (12")	750	297.9	320	340	112

※1: "d" shows the inside diameter of the meter.
※2: Figures listed on the weight column are in case of JIS 10K RF

■ Precautions for Use

1. This flowmeter is developed, designed, and manufactured to be used as a flowmeter for general industrial application. Therefore, when it is used for the application where its operation is directly related to the safety of the relevant system or the product is important in the facilities (such as process control and custody transfer), you are requested to ensure sufficient security including safety design, redundancy and duplication of the process, and implementation of periodic inspection. Do not use this flowmeter where its operation and performance directly affect human life.
2. When used under appropriate conditions, this flowmeter can demonstrate its stable performance without aging degradation of accuracy. However, malfunction or failure may occur due to various factors. Thus, examining the operating conditions, operating status, and importance in the process, you should consider periodic maintenance of your flowmeter. In order to secure long-term and safe use, OVAL recommends the customer to verify the soundness of the flowmeter through periodic inspection every two years. For the details of inspection, contact OVAL service agent.
3. This flowmeter is manufactured, adjusted, and inspected to meet the conditions of use. The fluid measured, flow range, pressure, temperature, etc., must be applied under the specified conditions. The conditions for use are stated on the nameplate attached on the flowmeter transmitter and specification sheet supplied with the product.
4. The materials (quality of material) used in this flowmeter are stated in this document or specification sheet shipped with the equipment. Supplied with all the necessary information by the customer, OVAL has selected materials that best suit the customer requirements including corrosion resistance. However, we ask you to understand that the final judgment on the compatibility of the materials in the actual process environment lies with the customer.

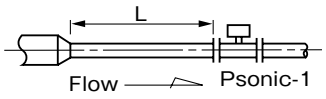
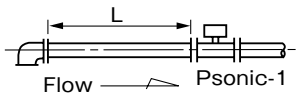
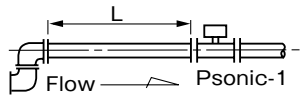
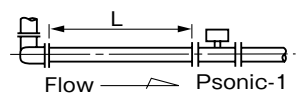
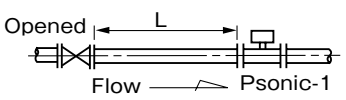
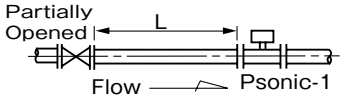
■ Precautions on Installation

When adopting an ultrasonic flowmeter, the following items must be considered from the viewpoint of flowmeter characteristics.

1. Piping shall be made in accordance with the standard piping procedure shown below.
2. If oil, mist, or dust is observed in the gas to be measured, install a separator.
3. Be sure to prevent dew condensation in the pipe.
4. Install the flowmeter away from the instruments that may generate noise, such as motor, blower, pressure-regulating valve, flow-regulating valve, etc.
5. If there is any power noise-generating instrument such as inverter, welding machine, etc., install a noise filter or noise cut transformer in the power line of the flowmeter.
6. Install the flowmeter in a place with little vibration and shock.
7. Install the flowmeter in a place where maintenance space can be secured around it.
8. When installing the flowmeter outdoors, use sunshade or similar to keep the flowmeter within the rated temperature range. The temperature inside the transmitter may exceed the rated temperature range under direct sunlight.
9. For the transportation and installation of the flowmeter, pay due care to implement transportation, installation, and removal operations safely by preparing hoisting means and pipe supports. Especially when hoisting the flowmeter, avoid applying a force to the transmitter or transducer. Otherwise, malfunction or damage may occur.

● Standard Piping

To derive the maximum benefit from an inferential-type flowmeter, it is generally required that the flow pattern at the inlet and outlet be made as uniform as possible. For this reason, we suggest using an OVAL flow straightener, or provide straight pipe sections conforming to the ISO-5167 as shown below. If it is difficult to secure the required straight pipe length, OVAL flow straighteners are available. For details, see General Specification Sheet NO.GCF001.

No.	Piping condition		Straight pipe Length (L) (D: Nominal size)	Remarks
1	Reducer		15D min	A reducer at upstream of meter.
2	Elbow		23D min	An elbow at upstream of meter.
			25D min	Two elbows horizontally at upstream of meter.
			40D min	Two elbows vertically at upstream of meter.
3	Full opened Valve		15D min	A full-open gate valve at upstream of meter.
4	Semiopened Valve		50D min	A partially-open gate valve, sharp orifice, or other devices that significantly disrupt the flow pattern at upstream of meter.

Notes : 1) Sch.40 pipe is used as the flow straightener standard.
2) A short pipe section, 5D or longer, must be provided downstream of the meter.

● Valves and Governors (reducing valves)

Locate the flowmeter sufficiently away from the sources of ultrasonic noise, such as valves (particularly butterfly valves) and reducing valves (governors). As a rule of thumb, keep the flowmeter away at least 50D (both upstream and downstream) from the valve. As for reducing valves, ultrasonic noise may appear at secondary-to-primary pressure ratios (absolute pressures) 0.7 or less; locate at least 40 meters from the reducing valve. If this length is not available, a special silencer is available from OVAL (see next page).

● Pressure Gauge and Thermometer Installation

Locate pressure gauge and thermometer taps at downstream of the flowmeter.

● Tees

Locate at least 20D (both upstream and downstream) from a tee where flows merge.

■ ABOUT THE SILENCER

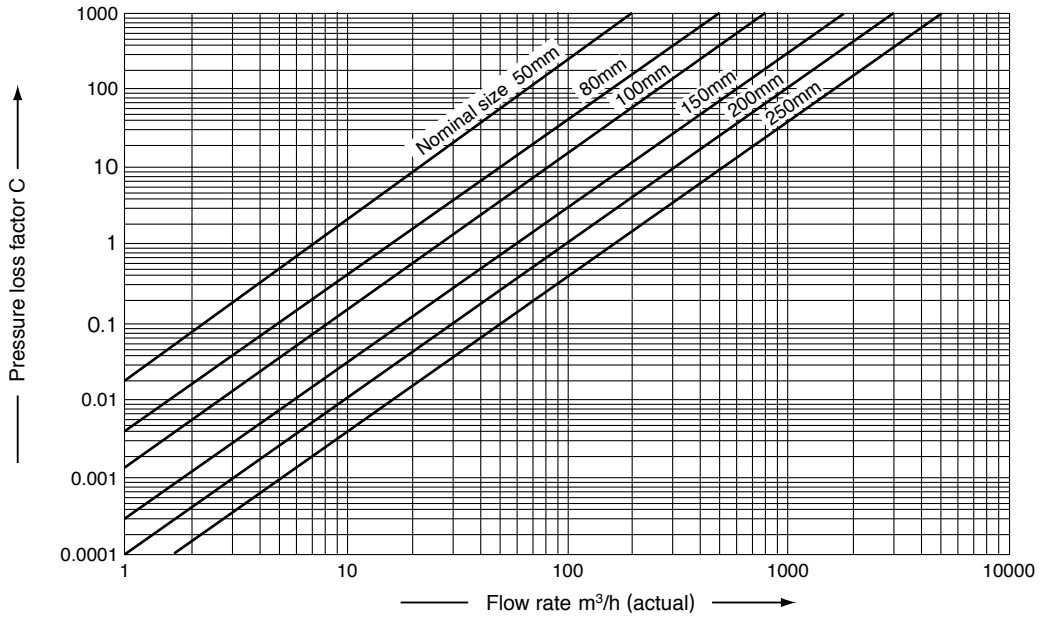
Located upstream or downstream of the Psonic-1, the silencer protects the flowmeter from the influence of ultrasonic noise generated by reducing valves or similar devices, attenuating the noise to negligible levels. To determine the pressure loss of a silencer, find the intersecting point C (pressure loss factor) of the flow rate and the slanted line of the applicable nominal meter bore, then substitute into the formula below.

$\Delta P = 0.01 \times C \times \rho$

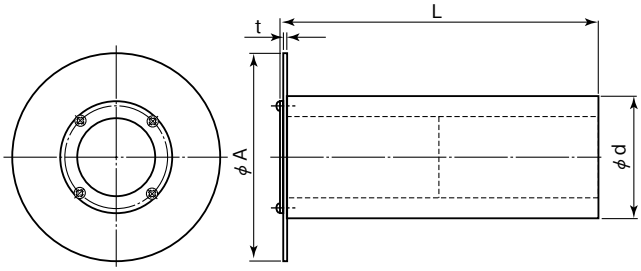
where ΔP : Pressure loss (kPa)

ρ : Density (kg/m^3)

● Silencer Pressure Losses



● Outline Dimensions [Unit in mm]



Nominal Size	d	A	L	t	Weight kg
25(1″)	25	70	75	2	0.1
40(1・1/2″)	39	85	120	2	0.3
50(2″)	50.8	100	150	2	0.5
80(3″)	76.3	130	200	2	0.9
100(4″)	100	155	200	2	1.2
150(6″)	149	215	300	3	3.3
200(8″)	198	265	400	3	5.2
250(10″)	246	328	500	3	8.6

■ TERMINAL CONNECTION

1	Power Supply	Hot (+)	
2		Neut (–)	
3	Analog Output	+	4 to 20mADC
4		–	
5	Pulse Output	+	Open Collector
6		–	
7	Status Output	+	Open Collector
8		–	
9	Communication	A	RS-485
10		B	
11	GND	Earth	

■ When you make inquiries, please state the following:

・Please complete the following form when making inquiries.

Item	Specification
1. Fluid to be Metered	
2. Flow Range	Max._____ Normal_____ Min._____ ☐ m³/min〔normal〕 ☐ m³/min〔actual〕 ☐ kg/min
3. Bidirectional Measurement	☐ Forward flow only ☐ Bidirectional flow
4. Temperature Range	Max._____ Normal_____ Min._____°C
5. Pressure Range	Max._____ Normal_____ Min._____ MPa〔gauge〕
6. Density or Sp. Gr.	Density_____ ☐ kg/m³〔normal〕, ☐ kg/m³〔actual〕, Sp.gr._____
7. Viscosity	_____ ☐ mPa・s, at _____°C
8. Connections	Nom. dia_____ ☐″, ☐ mm, Inside Dia._____ mm Flange rating ☐ JIS_____K RF ☐ JPI _____RF
9. Straight Pipe Lengths	Upstream straight pipe length ☐_____D ☐ Flow straightener
	Downstream straight pipe length ☐_____D
10. Correction	☐ Temp./press. correction ☐ Pressure correction ☐ Temp. correction ☐ No correction
11. Correction Range	Temperature_____ to _____°C, Pressure_____ to _____ MPa [gauge]
12. Correction Reference	Temperature reference_____°C Pressure reference_____ MPa [gauge]
13. Compression Coeff. (gas measurement)	Z (service) = Zo (under standard conditions) =
14. Calibration	☐ Fluid ☐ Dry
15. Output Signal	☐ Factored pulse Pulse unit_____ /P
	☐ Analog output Full scale_____ to _____ _____ /h
16. Companion Instrument	☐ Remotely located receiving instrument (Specify model and spec.)
17. Explosionproof	☐ Non-explosionproof ☐ Explosionproof
18. Remarks	